AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 2

OPERATING INSTRUCTIONS

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2.0 INTRODUCTION

This section of the manual contains a detailed description of front panel operation. Included are details on the generator, the receiver (or analyzer) and some of the special functions.

For a more detailed description of some of the special functions and operations via the interface ports refer to Section 3, Programming Operation.

The reader should refer to the front panel of the instrument to locate the various keys described in this section. A reproduction of the front panel graphics is included at the end of this section.

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2.1 RECEIVER SECTION

The RECEIVER section contains a level measuring function (also called an AC voltmeter, dB meter, noise meter, etc.) and a distortion meter (also called distortion factor meter or, incorrectly, a distortion analyzer). As the level meter has a high sensitivity and selectable response weighting, it may also be used as a noise meter.

Most operations of the receiver require a single key stroke and are independent (one function is not conditional on another). In general, they result from a desire of the operator to choose a mode of operation, modify a measurement or change a method of data presentation (as opposed to an internal requirement of the instrument such as "nulling" or "ranging" as found on earlier manual instruments).

2.1.1 IMPEDANCE

Impedance is a significant factor in several areas of the 5500. There are eight major parameters that are concerned with impedance. Each of these can have an effect on measured and/or generated values. They are:

a) Generator Source Impedance - This is the output impedance of the 5500 generator, that is, the drive impedance seen by the load looking back into the generator. See Section 2.2.5.

b) Generator Load Impedance - This is usually the input impedance of the external device under test. While its nominal value may be known, only an actual measurement can determine the precise value. (E.g., a device may have a nominal 600 ohm input impedance but the actual impedance may be 603.7 ohms.)

c) Specified Generator Load Impedance - This is the user entered value telling the 5500 the actual device under test input impedance or the 5500 generator external load. It is entered on the keyboard, stored in non-volatile memory and used to determine generator output level. (Note there are two values - one for dBm, one for V and dBV.) See Section 2.2.6.

d) Generator dBm Reference Impedance - When the generator output amplitude is specified in dBm, the reference impedance used to calculate the dBm value is the specified load impedance. E.g., if the external load is specified as 600 ohms, a requested output amplitude of 0 dBm will produce 0.7746 V rms in the external 600 ohm resistor. However, if the external load is specified as 150 ohms, a requested output amplitude of 0 dBm will produce 0.3873 V rms into an external 150 ohm load.

e) Device Under Test Output Impedance - The output source impedance of the device under test will form a voltage divider with its load, usually the input impedance of the 5500, to affect its output level. E.g., a device with a 600 ohm output impedance and producing 0 dBV into an open circuit will produce -0.052 dBV into a 100 k ohm load, the unbalanced high impedance input of the 5500.

f) 5500 Input Impedance - This is the load placed by the 5500 on the output of the external device under test. It is chosen by the user from 3 possibilities. See Section 2.1.9.

g) 5500 dBm Measuring Impedance - As dBm is in fact a power measurement, both the voltage level and impedance are used to calculate dBm. This is set either by the user-chosen input impedance or the user-chosen dBm reference impedance (Special function 26). It is not the same reference used for output dBm calculations. See Section 2.4.2.

h) Watts Impedance Reference - Like dBm, Watts is a power measurement. It is indicated on the 5500 by measuring Voltage and calculating power using a user specified load impedance value. This value is only the calculation value, the actual load must be supplied by the user externally. See Section 2.4.1.

Careful attention to each of the above factors will avoid errors, ambiguities and other problems.

2.1.2 FUNCTION

The row of buttons in the FUNCTION group chooses the basic function of the instrument. Two subgroups are possible - LEVEL and DISTORTION. LEVEL may be wide band or narrow band and DISTORTION may be total harmonic or intermodulation (if the IMD option 002 is provided).

2.1.3 WIDE BAND LEVEL

This function is the AC voltmeter or dB meter mode. The 5500 will automatically measure and display the level of a signal in the range of +40 dBm (100 V) to approximately -100 dBm (10 μV) (lower readings may be possible with band limiting). The reading can be expressed in Volts, mV or μV; in Watts, mW or μW or in dBm or dBV. The frequency range of measurement is 10 Hz to over 500 kHz.

This mode always internally measures the AC Voltage on the input even when the measured result is displayed in Watts or dBm. These "power" readings are derived by calculation from the Voltage measurement by assuming an (internal or external) load impedance. In the case of Watts, the default impedance is 8 ohms, in the case of dBm the default impedance is 600 ohms. Both impedances can be user modified. See Reference Impedance in Section 2.4.

2.1.4 NARROW BAND LEVEL

This mode is similar to Wide Band Level except a programmable filter is inserted into the measurement path. Dynamic range, overall bandwidth and available display units are all the same as the wide band level mode.

The filter type may be selected from a choice of three available configurations: Band Pass, Low Pass or High Pass. In the Band Pass mode, four bandwidths (or filter Q's) are available: very narrow, narrow, medium, and broad (Section 4 describes the shape factors of these filters in detail). The High Pass and Low Pass modes are each 2-pole Butterworth characteristic with 12 dB per octave roll-off. Each of these six shapes is selected one at a time, as the NARROW BAND key is pushed repeatedly.

The center frequency of the band pass response or corner frequency of the high or low pass response may be specified in one of two possible ways. The default condition is for the filter to follow the internal oscillator. Thus it is automatically set to the same frequency as the generator every time a Source Frequency is specified (see Section 2.2.1). Alternatively, the band pass filter may automatically track the input in an auto-tune mode. This requires first that the input signal be -30 dBm/30 mV or greater and second, in the frequency range 10 Hz to 100 kHz. The instrument will then measure the input frequency and automatically and continuously tune the filter to this frequency. To turn on the auto-tune mode, select Special Function 28.2. To return to the normal "follow oscillator" mode, select Special Function 28.0.

2.1.5 TOTAL HARMONIC DISTORTION plus NOISE (THD + N)

This mode measures the THD+N of the input signal by the common fundamental rejection method. That is, the fundamental of the input signal is eliminated by an automatic rejection circuit, the remaining residual signal is measured and its amplitude is expressed as a ratio of the input signal amplitude. Depending on the nature of the input signal, this residual may be predominantly harmonics, noise or some combination of each. Hence the nomenclature Total Harmonic Distortion plus Noise.

The result of the ratio calculation may be expressed as either a dB figure or a percentage figure under control of the shifted UNITS key.

Note that the fundamental rejection circuits and ratiometric measurement and calculation circuits are all totally automatic in operation. Frequency tuning, ranging and nulling are all automatically controlled by the internal computer in response to the input signal.

The instrument will measure the THD+N of signals with levels between - 30 dBm (30 mV) and +40 dBm (100 V) and fundamentals between 10 Hz and 100 kHz. Signals outside this range will generate an error condition. (Error 20 or 21 and Error 26 respectively)

If the input signal is particularly noisy and unstable but the test signal source originates from the 5500 generator, it might be desirable to override the automatic tuning to inhibit random "hunting". An example of such a situation might be SINAD measurements on a communications receiver or distortion measurements on a loud speaker or tape recorder with poor signal-to-noise ratio. It is possible to suppress the auto-tuning and force the THD notch filter to always track or follow the internal oscillator. In this mode, every time a new Generator Source frequency is entered (Section 2.2.1), the THD filter will be set to and held at this same frequency. To select this mode, select Special Function 6.1. To return to the normal auto- tune mode, select Special Function 6.0.

A more generalized case of the "track oscillator" mode can be enacted by using Special Function 37. Whereas Special Function 6 concerns the tuning mode of the notch filter in the THD mode only, Special Function 37 affects filter tuning in all modes (THD and Narrow band level) and also the detector integration time constants and the displayed frequency value. Each of these under normal conditions is determined by the frequency of the INPUT signal. That is, the auto-tuning of the notch in THD and the band pass filter in Narrow band, the detector integration time in all modes and the displayed frequency value in all modes is determined by a measurement of the input signal. By selecting Special Function 37.1, all of these functions are instead slaved to the internal oscillator; 37.0 returns to the normal default state.

37.1 is useful to gain a speed advantage in almost all THD measurement situations (but the frequency of the INPUT test signal must be close to that of the 5500 generator). If the input signal is constantly being interrupted, for example as multiple devices under test are sequenced, this mode will prevent the tuning lock interruption as the input signal is changed. The filter will remain tuned to the internal oscillator (and the FREQUENCY display will continue to give the oscillator frequency) even when the input signal is removed. When the input is reconnected, the filter nulling will proceed faster as the filter is already tuned. To select the oscillator tuning mode, set Special Function 37.1. To return to the normal input tune mode, set Special Function 37.0. Remember that if Special Function 37.1 is set, the input signal must be the same frequency as the 5500 source. If not, an erroneous reading will result. Also remember that this mode changes the FREQUENCY display to be GENERATOR FREQUENCY rather than INPUT FREQUENCY.

2.1.6 INTERMODULATION DISTORTION (IMD)
(Requires option 002)

This mode measures the intermodulation products generated in a device under test when stimulated by an appropriate dual frequency signal. This is the only function of the receiver section that has an influence on the generator section. When this mode is selected, the generator changes to a twin tone signal from its normal single tone mode.

Two types of IMD are measured (and generated). The primary mode is SMPTE or DIN consisting of a high frequency signal and a low frequency signal mixed in a 1:4 amplitude ratio. When the mode is entered, if the generator (HF) frequency is below 2 kHz, it is set to 7 kHz but may be later changed to any high frequency between 2 kHz and 100 kHz. The low frequency is the one most previously used but may be changed to one of eight low frequencies between 40 Hz and 500 kHz (see Section 2.2.2). Note that when this function is first selected after a default state power-up, the low frequency is at the default value of 60 Hz.

The second IMD mode is CCIF and is selected by using the shift key. This mode measures the low frequency difference component of a twin tone high frequency test signal. The difference frequency may be any frequency from 80 Hz to 1 kHz while the mean frequency of the dual tone high frequency may lie between 2 kHz and 100 kHz. As in THD+N, the results may be expressed as a dB ratio or a percentage.

2.1.7 DC Measurement (Requires option 008)

Instruments equipped with option 008 are able to measure DC Voltage with three selectable ranges. This function is selected as a SHIFT of WIDE BAND LEVEL.

The instrument measures the DC component of the selected input: A or B. It will respond to either polarity and correctly enunciate the sign in the readout.

The default range is 100V full scale with a 100 mV resolution. Two additional ranges are provided that can accommodate down to 1V full scale with 1mV of resolution. Ranges are selected by Special Function 2. The following table shows the range, resolution and method for selection for each range.

Table 2.1.7 DC Volts Range Select

Measurement Range	Resolution	Selection
100.0 to 0.0	100 mV	2.0 SPCL
10.00 to 0.00	10 mV	2.1 SPCL
1.000 to 0.000	1 mV	2.2 SPCL

2.1.8 Phase Measurement (Requires option 009)

The instrument is able to measure the relative phase difference between two signals of the same frequency with the addition of option 009. This mode is selected as a SHIFT of NARROW BAND LEVEL.

The system measures the relative phase between the signal presented to INPUT A and the **selected** input. That is, if input B is selected on the INPUT SELECT control, the phase difference between the signals at A and B will be measured. Alternatively, if INTERNAL OSC A is selected, the phase shift between the Generator A Output and INPUT A will be measured. The phase measurement facility is the only one on the instrument to use two signals simultaneously.

Two ranges are provided to allow accurate measurements over a full 360° range. As is typical with phase meters, measurements of two signals with very small phase differences can give ambiguous results (for example, near 0° or 360°). Changing to a different range inverts the reference and adds 180° to the reading to avoid this ambiguity. The net effect of the double inversion (signal polarity reversal and mathematical addition of 180 to the measured value) ensures that the displayed reading is always correct.

The phase ranges are selected by Special Function 8. The following table shows the recommended operation of this phase range selection.

Table 2.1.8 Phase Range Selection

Total Range	Recommended Range	Selection
±180°	-170° to +170°	8.0 SPCL
0 to 360°	10° to 350°	8.1 SPCL

Note that the choice of ranges is transparent to the readout. For example, a value of +60° could be read equally on either range. However, a value of 182° would be best read on the 0 to 360° range (8.1 SPCL) while a value of 2° would be best measured on the ±180° range (8.0 SPCL).

2.1.9 FILTERS

Several band limiting and noise weighting filters are available. These are useful to reduce the effects of extraneous noise during distortion measurements or provide frequency response weighting for noise measurements.

Four standard filters are provided and four more are optional.

The 400 Hz High Pass filter can be used to reject low frequency noise and mains hum. It is a 3-pole Butterworth filter and provides over 40 dB rejection at 50 or 60 Hz. It may be used when making THD+N measurements of signals with fundamentals of 1 kHz or greater. The filter is selected and deselected on a push on/push off basis with the first filter key. This filter is independent of other filters and may be selected in conjunction with others.

The 30 kHz and 80 kHz Low Pass filters may be used to reduce the measurement bandwidth in THD+N and other modes. These are 3-pole Butterworth filters (18 dB per octave roll-off). They are generally used in THD+N if the fundamental of the signal being measured is less than one third to one fifth of the filter cutoff frequency (e.g. 10 kHz fundamental or lower for 30 kHz filter, etc.).

The fourth filter (SPCL) will be one of 3 possibilities:

Standard	ANSI/IEC A Weighting
Option 101	CCIR 468-3
Option 102	Psophometric (CCITT P53A)

The choice of which of these three is determined at the factory at the time of order and indicated by a suitable panel label over the button.

In addition to these four standard filters, four optional additional filters may be provided.

The optional group of four additional filters may be one of the following two groups:

1) **Option -005 Audio**
contains the following four filters:

a) Audio band pass, 36 dB per octave roll-off at each end. Specify 20 Hz to 20 kHz or 22.4 Hz to 22.4 kHz
b) IHF Band Pass : 200 Hz to 15 kHz with 19 kHz notch.
c) ANSI "A" Weighting (also called NAB).
d) CCIR 468-3 weighting (also called Dolby).

2) **Option -006 Telecommunications**
contains the following four filters:

a) 3 kHz Flat (Bell 41009 or IEEE 743).
b) 15 kHz Flat (Bell 41009 or IEEE 743).
c) Program (DIN 45405 and Bell 41009/IEEE 743).
d) C Message with notch (Bell 41009 or IEEE 743).

On special order, a mix of filters from options -005 and -006 may be supplied to a maximum of four auxiliary filters.

Note that with the exception of the 400 Hz High Pass filter, only one of the remaining up to seven filters may be selected at any one time.

2.1.10 INPUT SELECTION

One of three (four) possible inputs may be selected: INPUT A, INPUT B or OSCillator A (or OSC B). A and B are two identical inputs on the front panel. OSC is the signal at the generator output and is used for self-check, send level verification, etc. To select the oscillator output, push and hold the SHIFT key and the A button. If the optional B OUTPUT is provided, it may be selected by pushing and holding the shift button while pushing the B button.

2.1.11 INPUT TERMINATION

All inputs are normally high impedance bridging (100 k ohms) but may also be set to a 600 or 150 ohm termination. (Note that the input termination operates on external INPUT A or external INPUT B but not internal OSC).

The input defaults to a 100 k ohm input impedance. By pushing the SHIFT key and the INPUT TERMINATION button, a 600 or 150 ohm input termination may be selected. Two independent operations happen when 600 or 150 is selected: if (external) INPUT A or B is selected, a physical termination resistor is placed across this selected input and secondly, the dBm reference impedance used to calculate the dBm reading is set to 600 or 150 ohms, as required. This impedance reference will remain until either changed by Special Function 26 or a new input termination is selected. Note that selecting 100 k ohms will remove the input termination but retain the last used (600 or 150) impedance for the dBm reference.

To illustrate, using an example: if an external source of 0.775 V open circuit and 600 ohm source impedance is connected to INPUT A, the LEVEL mode will indicate 0 dBm in the 100 k ohm mode, -6 dBm in the 600 ohm mode and -7.96 dBm in the 150 ohm mode.

Again note that the physical termination resistors only affect the INPUT A or INPUT B external sources. The internal OSC connection cannot be terminated (except of course by using an external cable between GENERATOR OUTPUT and analyzer INPUT).

CAUTION

Note that the input termination resistors can dissipate a maximum of 1 Watt continuously. This is represented by the following conditions:

INPUT TERMINATION	MAXIMUM dBm	MAXIMUM Volts
600 ohms	+30 dBm	24.5 V rms
150 ohms	+30 dBm	12.3 V rms

Input conditions greater than this can permanently damage the termination resistors. If an input is selected, a termination is on and the input conditions exceed the 1 Watt limit, the instrument will automatically disconnect the termination to avoid damage. All terminations are also temporarily disconnected during instrument fatal error states and reset after the errors are cleared.

See Section 1.3 for more information on input configurations.

2.1.12 DETECTORS

The 5500 has three amplitude detectors, selectable by the user. The detectors are true rms, average and quasi-peak. All three detectors are calibrated to read the rms value of a pure sine wave.

True rms will yield the most accurate results of a complex waveform such as noise or distortion. Average will allow comparison of readings with those from older average responding instruments. Quasi-peak measures noise to particular standards such as CCIR 468-3.

The choice of one of three detector characteristics is made by the DETECTOR button (above the SHIFT key).

2.1.13 INTEGRATION

Notably absent from the 5500 is any means to choose the integration time (sometimes called averaging time or smoothing). This is because this function is automatically handled internally. Since the 5500 always measures the frequency of the input signal, it is able to choose the optimal time constants automatically.

If desired, this automatic time constant selection can be overridden using Special Function 29.

A further feature enhances integration. The 5500 uses a proprietary process called Synchronous Integration that yields an excellent result to the usual settling-time/ripple compromise present in AC level measurements. Under normal conditions, satisfactory integration of low frequency detection to yield acceptable smoothness and accuracy also implies very long settling time.

The 5500 avoids this trade-off and is able to yield virtually ripple free readings within one cycle of the input signal - a time improvement of up to an order of magnitude.

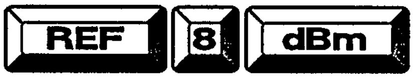
2.1.14 RELATIVE MODE

The relative mode allows the current measured value to be expressed as a ratio (dB or %) of a stored reference. For example, signal to noise is the ratio of noise to the peak or program level. Gain is the ratio of output level to input level.

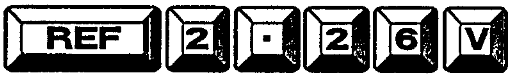
Two distinct operations must be performed to use the relative mode. First, the reference must be stored (if not previously done) and secondly, the relative mode must be selected. These two operations may be done in any order.

The reference may be stored in two ways: as a keyboard entered value or as the currently measured value (of the input signal).

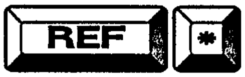
To store a relative reference, push the REFERENCE prefix key (bottom key in the column below the RELATIVE KEY). Then enter the desired reference value on the numeric keys. Finally, terminate the entry with the dBm, dBV, V or % keys (note that % is a shifted key), for example, to enter a reference of +8 dBm, key in:



Or, for a reference of 226 Volts :



To enter the presently **measured** value simply push the "*" key after the prefix. No terminator is required. For example, to set the currently measured program level as the reference (assuming this value is currently being displayed on the left display) push:



Having thus stored a reference, the relative mode can be enacted by pushing the RELATIVE key. Absolute readings are again selected by a second push. The stored reference is not altered until a new reference is entered.

For example, assume a reference of +8 dBm has been previously stored and the noise level being measured is say -65 dBm. If the RELATIVE key is pushed, the reading will change to -73 dB (the ratio between +8 and -65). When the key is pushed again, the absolute value of -65 dBm returns.

Another example: assume a value of 0.46 V was stored as a reference and the current measured value is 3.6 V. If the RELATIVE key is pushed, a reading of 783% will be displayed as the ratio of 0.46 to 3.6. That is, the new measured value is 783% of the stored reference. This could be easily converted to a dB figure by selecting a log units display. Push and hold the SHIFT key and push the UNITS key to see +17.88 dB.

Setting the relative mode and storing the current measured value as the reference can also be accomplished as a single operation. The shifted mode of the RELATIVE key accomplishes this. To set, push and hold the SHIFT key and then the RELATIVE key. The display will now change to 0.0 dB or 100% and all future readings will be relative to this current value.

Note: A separate reference is maintained in memory for both DISTORTION and LEVEL measurements. The DISTORTION reference is stored as a ratio and the LEVEL reference as an absolute value.

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2.2 GENERATOR SECTION

The generator consists of a programmable frequency, high performance oscillator, a high power output amplifier, a programmable output attenuator and configuration switching. If the IMD option 002 is provided, a second low frequency oscillator is included as well as the ability to generate a twin tone high frequency signal.

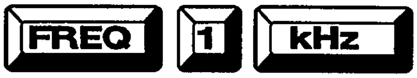
Many generator parameters are set by multiple key strokes. The normal syntax of data entry is :

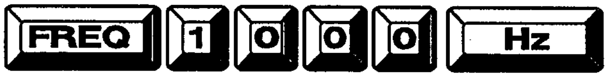
PREFIX - DATA - TERMINATOR

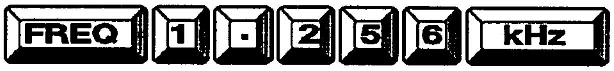
The PREFIX establishes what is going to be set such as frequency or amplitude. DATA is entered as a numeric value on the numeric keyboard. The TERMINATOR, typically a units key, functions as an "ENTER" key and executes the just entered parameters. As soon as the first data key is pushed, the right hand display changes from its previous role (of frequency indicator) to a "data entry" indicator. Digits will enter at the right and move left. When the terminator key is pushed, the display clears and reverts back to its previous function.

2.2.1 GENERATOR FREQUENCY SELECTION

In all modes, except the optional IMD mode, the generator may be set to any frequency between 10 Hz and 100 kHz. To set the generator to a particular frequency, first push the FREQUENCY prefix key followed by one to five data keys followed by the Hz or kHz terminator key. For example:







The right hand display will usually be indicating the actual *measured* frequency of the oscillator (if OSC input is selected or INPUT A or B contains the oscillator signal via the device under test). The measured value will almost invariably be at least slightly different from the programmed value (or user entered frequency). Bear in mind that the frequency indication is 5 digits of resolution, a resolution of 0.01% while the oscillator is *not* a synthesizer. It has a typical frequency accuracy of ±1%, normal for a low distortion RC type oscillator. The frequency meter resolution is 100 times the oscillator frequency accuracy and will tend to magnify the appearance of the error.

The user can see the *programmed* frequency (rather than the measured frequency) by pushing and holding the FREQUENCY prefix key.

If an invalid frequency entry is attempted, an error will be displayed. Examples of errors would be requesting a frequency outside the generator range (e.g., 1 MHz), keying in too many data digits (more than 5) or an improper terminator (Volts, for example).

A special method of frequency entry may be useful in certain circumstances. If the 5500 is reading the frequency of an external source (not the 5500 internal oscillator) and it is desired to set the internal oscillator to that frequency, the first inclination would be to key in the digits of that measured frequency. However, a simpler way exists. The "*" key uses the currently measured value as DATA. So, to set the internal oscillator to the measured external frequency, just push the FREQ prefix key followed by the * (no terminator is required). The oscillator should now be programmed to the frequency of this external source.

2.2.2 IMD FREQUENCY (requires option 002 IMD)

The FREQUENCY prefix key in the IMD mode sets the HF component of the SMPTE/DIN signal or the mean frequency of the CCIF signal. The lower limit of the analyzer is 2 kHz. If a lower frequency is entered in the IMD mode, the resulting measurement will be non-valid.

The LF component of the SMPTE/DIN signal or offset frequency in the CCIF mode is set using the IMD LOW FREQUENCY prefix key. Eight frequencies are available: 40, 50, 60, 80, 100, 125, 250 or 500 Hz. If a number other than these is entered, the available frequency closest to the entered value will be automatically selected.

Note that when the SMPTE/DIN IMD function is selected, if the HF is below 2 kHz, it is automatically set to 7 kHz. The LF is set to the last used value. The user may then override these values with additional numeric entries. If another function is selected and IMD SMPTE/DIN again selected, the previously used frequencies will be used (unless the HF has been set to below 2 kHz while another function was selected).

On first power-up, the LF oscillator is set to its default value of 60 Hz. Therefore, the first time the IMD function is selected after default state power-up, 60 Hz will be used. If the LF oscillator is manually changed to a different frequency, it will remain at this new manually entered frequency until either again manually changed or until the instrument is powered down.

The offset frequency in the CCIF mode is one half the difference frequency. For example, if a high frequency/mean frequency of 10 kHz and a low frequency/offset frequency of 60 Hz is selected, then the following outputs will be observed:

SMPTE mode :	HF:	10 kHz
	LF:	60 Hz
CCIF mode :	F1:	10060 Hz
	F2:	940 Hz

2.2.3 NARROW BAND FREQUENCY

One of the four meter functions is Narrow Band Level. This mode inserts a band pass, low pass or high pass filter in the measurement path. The center frequency of the band pass or the corner frequency of the high or low pass can be entered by setting the generator to the desired frequency. The filter will automatically be set to the same frequency as the internal generator. It is also possible to have the filter automatically track the frequency of the INPUT signal (if the INPUT is -30 dBm/30 mV or greater) by setting SPECIAL FUNCTION 28.2. SPECIAL FUNCTION 28.0 returns the filter to the manual mode (see Section 2.1.4).

2.2.4 GENERATOR AMPLITUDE (requires option 001 High Level Balanced Output)

The generator output amplitude is a function of several factors:

a) Requested amplitude as specified by a keyboard entry (or GPIB command)

b) Specified external load impedance (also keyboard or GPIB)

c) Actual external load impedance

d) Generator source impedance (50, 150 or 600 ohms)

e) Units used: dBm, dBV or Volts

All of the above factors will have an effect on the signal level delivered to the load. Insufficient attention to this detail can lead to unanticipated errors. For example, if the user specifies a load impedance of 600 ohms but the actual load is say, 592 ohms, the signal will be low by about 1% with a generator source impedance of 600 ohms or about 0.1% with a 50 ohm source.

Section 2.2.6 following describes how to set the specified external load impedance. The values entered will be used for all output amplitudes. The default conditions are infinity (open circuit) in the Volts or dBV mode and 600 ohms in the dBm mode.

To select a generator output level push the AMPLITUDE prefix key followed by one to five data entry keys followed by a units terminator key. The requested level will then be presented to the user defined load (assuming the specified load and the actual load are identical).

The output range, in the balanced mode, into an infinite load (open circuit) is 33 V rms maximum to below 300 μV rms (+30 dBV to -70 dBV). The output range, in the balanced mode, into an external 600 ohm load from a 150 ohm source is +30 dBm to -70 dBm. Maximum signal levels in the unbalanced mode are approximately one half of the balanced levels. Lower signal levels can be requested and achieved but with progressively degraded resolution and signal-to-noise ratio. The normal amplitude resolution is better than approximately 0.03 dB or 0.3% (i.e. 3 mV at 1 V).

CAUTION

The maximum output levels available from the 5500 are higher than typically available from bench generators by a factor of 2 to 4. Damage to a device under test can result under certain conditions. Use levels above +10 dBm/dBV/3V with caution. The output power amplifier is capable of delivering several Watts of power to an external load. It is internally protected against overload conditions and short circuits, nevertheless, unnecessary sustained operation at maximum output into low impedance loads should be avoided to minimize internal heat dissipation. The generator gives the same performance with or without a load; if the device under test is a high impedance input, it is not necessary to provide a dummy load termination to the generator.

As in the frequency mode, the * key can also be used to set the generator output amplitude to the currently measured INPUT amplitude. For example, if the 5500 is reading +8 dBm from an external source in the Level mode and the AMPL and * keys are pushed in sequence, the generator would then be set to +8 dBm output.

If an amplitude of 0 V is entered as the generator amplitude, the output is set to zero and the oscillator will be internally turned off to avoid any possibility of signal leak through.

The user programmed amplitude can always be displayed by pushing and holding the AMPL key. This displays the current programmed generator output amplitude (as opposed to the measured amplitude) while the key is held.

2.2.5 OUTPUT SOURCE IMPEDANCE
(requires option 001 High Level Balanced Output)

Three output source impedances and configurations are possible:

SOURCE IMPEDANCE	CONFIGURATION
600 ohms	Balanced
150 ohms	Balanced
50 ohms	Unbalanced

The three possibilities are selected by successive pushes of the CONFIGURATION button. In the balanced modes the output should be taken from the tip-ring-sleeve jack, in the unbalanced mode the signal should be taken from the BNC jack. The signal is available on both jacks in both modes but erroneous levels and/or grounding problems may occur if the wrong jack is used. The panel graphics clearly indicate the correct jack to use. Note that when a plug is inserted into the BAL jack, the UNBAL jack is disconnected.

The highest drive level will be obtained by selecting the 150 ohm balanced configuration. This mode will permit a +30 dBm drive into an external 600 ohm load (1 Watt). The 600 ohm balanced mode should be used for equipment that requires a true 600 ohm source impedance. The 50 ohm unbalanced configuration should be used for unbalanced equipment such as consumer audio components that could be damaged by the high signal levels possible in the balanced modes.

2.2.6 OUTPUT LOAD IMPEDANCE

The 5500 stores two internal values of external load impedance, one for dBm and another for all other units (V, dBV). These stored values are used to calculate the actual generator output drive level to produce the correct level in the external load. The calculation also takes into account the specified output level and the generator source impedance. Every time any of these is changed, the level is recalculated to insure the correct value in the external load.

The load impedance default values are as follows:

dBm:	600 ohms
dBV and Watts :	infinity (open circuit)

The values can be changed by using a special function. In the dBm case, the assumed load can take values from 1 to 9999 ohms. In dBV and Volts, the load can be 1 to 9998 ohms or infinity (open circuit). Note that dBm, being a unit of power, cannot assume an infinite load. For dBm the SPCL FNCT is 5, for Volts and dBV it is SPCL FNCT 4. To enter a value, key in the SPCL FNCT number (4 or 5) followed by a decimal point followed by the value in ohms from 1 to 9999 and terminated by the SPCL key. (In the dBV or Volts case, the value of 9999 will represent infinity or open circuit). For example, to set the dBm external load to 150 ohms, key in:

5 . 1 5 0 SPCL

Note that in the dBm case the load impedance is also the dBm reference impedance, that is, the output level will be set using the true meaning of dBm, not using dBu or dBm referenced to 600 ohms.

To determine the currently stored load impedance, key in 4.0 SPCL or 5.0 SPCL. The left hand display will show the stored value.

2.2.6.1 MINIMUM LOAD IMPEDANCE

The power amplifier used in the generator is subject to certain constraints. One of these is the maximum voltage it can produce. A second is the internal dissipation it can handle. To provide protection for the latter, the power amplifier has a current limit feature. This insures that no damage will occur even if the output is short circuited.

The combination of the voltage constraint and current limit will define the maximum output capability for various source and load impedance combinations. Conditions that exceed these limits will cause the amplifier to current limit (to clip) as a dissipation protection but without warning the user.

The user must specify the value of the external load impedance, the generator source impedance and the desired signal level delivered to the external load. The 5500 computer then calculates the power amplifier drive level required to produce this desired signal level in the external load. If the drive level exceeds the power amplifier voltage capability, an error condition is generated. However, if the voltage is within limits but the current is exceeded, no error is generated. Similarly, if an external load impedance below the specified load impedance is used, the amplifier may current limit (clip).

Certain extreme conditions of overload can actually shut down the entire 5500 instrument due to power supply protective fault monitoring.

Table 1 illustrates the minimum value of external load impedance that can be used without causing the power amplifier to current limit. As a single power amplifier is used to drive both the A and optional B output, the limit changes depending on whether one or both outputs are being used.

Table 2 illustrates the maximum output in dBm that is possible under various source and load impedance variations. Note that the dBm value follows the strict definition as power relative to 1 mW - not dBm/600 ohms or dBu as is read on most dBm meters. Also, remember that the 5500 uses this mathematically correct dBm interpretation when calculating its output level. If the instrument is told the external load for dBm is 150 ohms for example (5.150 SPCL), then an impedance of 150 ohms is used in the dBm calculation. 0 dBm will be 1 mW or 0.387 V in the external 150 ohm load in this case.

TABLE 2.4.1

MINIMUM EXTERNAL LOAD IMPEDANCE THAT WILL NOT CAUSE CURRENT LIMITING

OUTPUT (SOURCE) IMPEDANCE	MAXIMUM OPEN CIRCUIT VOLTAGE	MINIMUM LOAD IMPEDANCE & RESULTING LOAD VOLTAGE	
		USING A ONLY OR B* ONLY	USING BOTH A & B*
50 ohms unbalanced	16.5 V	50 ohms / 8.3 Volts	150 ohms / 12.4 Volts
150 ohms balanced	33 V	50 ohms / 8.3 Volts	250 ohms / 21 Volts
600 ohms balanced	33 V	0 ohms / 0 Volts	0 ohms / 0 Volts

*NOTE: Use of Output B requires Option 007.

TABLE 2.4.2

MAXIMUM OUTPUT POWER IN dBm (relative to 1 mW) for various output load impedances (rms Volts delivered to load)

OUTPUT (SOURCE) IMPEDANCE	**EXTERNAL LOAD IMPEDANCE (OHMS)**				
	50	**100**	**150**	**300**	**600**
50 ohms unbalanced	+31.3 dBm (8.3 Volts)	+30.8 dBm (11.0 Volts)	+30.1 dBm (12.4 Volts)	+28.2 dBm (14.1 Volts)	+25.9 dBm (15.2 Volts)
150 ohms balanced	+31.3 dBm (8.3 Volts)	+32.4 dBm (13.2 Volts)	+32.6 dBm (16.5 Volts)	+32.1 dBm (22.0 Volts)	+30.7 dBm (26.4 Volts)
600 ohms balanced	+21.2 dBm (2.5 Volts)	+23.5 dBm (4.7 Volts)	+24.6 dBm (6.6 Volts)	+26.1 dBm (11.0 Volts)	+26.6 dBm (16.5 Volts)

2.2.7 GROUND/FLOAT

The shifted mode of the CONFIGURATION button allows the output to be ground referenced or floated. The normal mode is internal GND reference. If the output is ground referenced via the external equipment being measured, the FLOAT mode may be selected to avoid a ground loop. The output must have a ground reference from one of the several possible paths: output GND mode, through the device under test or via an external ground connection.

In the GND mode, the center tap of the BALANCED output is connected to chassis and the low side of the UNBALANCED output is connected to chassis. This chassis connection is via a voltage dependent resistor/capacitor network for protection.

2.2.8 OUTPUT ON/OFF

The top push button in the OUTPUT group is the output ON/OFF function. This can be used for signal-to-noise ratio measurements or other applications requiring a quiet termination. When the output is OFF, the source impedance remains the same as in the ON mode.

2.2.9 B OUTPUT (if option 007 provided)

The shifted mode of the ON/OFF key selects the optional dual output. If the second (B) output module is provided, the output may be set to feed A only, B only, A and B in phase or A and B out of phase. Both outputs have the same level, source impedance and configuration. The two outputs are resistively isolated but come from a common power amplifier. See Tables 1 and 2 for combined output load limitations.

2.2.10 EXTERNAL INPUT

An external input is provided on the rear panel of the 5500 to allow the user to supply an external special source signal (such as a function generator, square wave, pink noise, etc.). To select the external source, key in 14.4 SPCL. To select the internal oscillator (default condition), key in 14.1 SPCL. The external source must have a nominal signal level of +10 dBV/3.16 V and will benefit from output power amplifier transformer isolation, output attenuator, output configuration and amplitude setting provision.

Every time a new FUNCTION is selected, the default signal source is again selected. For example, if the instrument is in the WIDE BAND LEVEL mode and Special Function 14.4 is selected, the external signal source will be on. If the THD function is now selected, the internal source (that is, the default source or 14.1 SPCL) will be selected at the same time that THD is entered. To use the external source in this new THD mode, again key in 14.4 SPCL.

2.2.11 SIGNAL SOURCES

Special Function 14 has a more general application. It may also be used to select any of the optional special signal sources that may be provided on the 5500. Table 2.2.11 lists the signal sources, special function code and conditions. As with the external input

(14.4 SPCL) described above, any change in FUNCTION always reselects the default internal sine wave source (unless IMD is selected. See below.)

This feature allows selection of a special source in an abnormal mode. For example, when the IMD function is selected, the appropriate IMD composite test signal source is automatically selected. This also means that the IMD test signal can only be selected in the IMD measurement mode. However, the IMD signal source can be selected in the WIDE BAND LEVEL mode by entering 14.2 SPCL. This allows measurement of the rms level of the composite IMD test signal, for example.

It is of course possible to enter illegal modes. Selecting an IMD twin-tone source in the THD mode will usually yield errors and at best a meaningless value. As the source is not explicitly indicated on the front panel and an unaware user could have difficulty sorting out an invalid state, the 5500 always clears the signal source to its default state at every function change. The default state in the LEVEL and THD modes is a single fixed frequency sine wave. In IMD it is a two frequency composite waveform. In the SWEEP mode, it is the swept sine wave source for LEVEL or THD and a swept composite source for IMD.

TABLE 2.2.11

SPECIAL FUNCTION 14
SELECTING GENERATOR SOURCE SIGNALS

SPCL FNCT	SIGNAL SOURCE	CONDITIONS
14.0	None	
14.1	Internal Sine Wave	Default source for level and THD
14.2	Internal IMD composite signal	Requires option 002. Default source for IMD. If selected in other modes, will be SMPTE or CCIF depending on last mode used.
14.4	External Input	Accepts rear panel input signal.
14.5	External Input and IMD	Requires option 002. Mixes external input with internal LF oscillator to produce composite SMPTE or CCIF source signal.
14.7		Internal Square Wave
14.8	Auxiliary Source 1	Requires option 003 Special Signals Group.
14.9	Auxiliary IMD Source	Requires option 002 and 003.
14.10	Auxiliary Source 2	Requires option 003.
14.11	Auxiliary Source 3	Requires option 003.
14.12	Auxiliary Source 4	Requires option 003.

2.2.12 FREQUENCY INCREMENT

In addition to the direct frequency entry described previously, generator frequency may be specified as a change relative to the current value. The amount of the change is set by the operator by using the increment mode. The generator frequency is changed by using the UP or DOWN MODIFY keys.

To enter the increment mode, push and hold the SHIFT while pushing the FREQ prefix. Next enter the desired increment value and then the proper units terminator. Terminators may be Hz, kHz or % (note that % is a shifted function). For example, the increment may be specified as 100 Hz, 1.1 kHz, 10%, 62%, etc. A Hz or kHz value will yield linearly spaced increments, % increments will yield log spaced increments. After the terminator key is pushed, the increment entry mode will be cancelled and the instrument will return to the direct entry mode. Then the UP and DOWN buttons will increment (or decrement) the generator frequency by the previously specified incremental value.

Avoid trying to increment to an invalid frequency. For example, setting an increment of 1 kHz, pushing DOWN when the current frequency is 1 kHz and thus requesting a new frequency of 0 Hz (Error 7).

The UP and DOWN keys are repeat keys. They can be held down for continuous stepping. The frequency will step sweep up or down at approximately 2 steps per second after an initial start delay of approximately 2 seconds. The measurement circuits of the meter may not respond fast enough at this speed to allow results to be displayed but, if the generator output is viewed on an oscilloscope, the increment sequence can be seen. Or SPCL function 10 may be selected to see the programmed (or set value) which will respond at the required speed to see the effect.

2.2.13 AMPLITUDE INCREMENT

The amplitude increment mode allows changing the generator output level by a user defined value. For example, stepping the output level in 1 dB, 0.1 dB or 100 mV steps. To use the increment mode first set the increment value. Push the AMPLITUDE INCREMENT prefix (SHIFT + AMPL keys). Then key in the value and finally the terminator. Valid terminators are dB, Volts and % (remember that % is a shifted key). After entry of a valid increment value, the increment entry mode will be cancelled and the AMPLITUDE mode automatically set. Then the UP and DOWN keys can be used to step the output amplitude by the previously set increment. As on the frequency mode, the UP/DOWN keys are repeat keys.

Note that the modify keys (UP, DOWN) act on generator frequency or generator amplitude depending on which prefix key has been pushed. Each mode (FREQ and AMPL) has its own stored increment value which remains until changed by the user.

2.2.14 IMD AMPLITUDE RATIO (requires option 002 IMD)

In the IMD modes, two oscillators produce a twin tone signal. The relative amplitude of the two signals can be user defined in the SMPTE mode. In the CCIF mode, the two signals are fixed at a 1:1 or equal amplitude but in the SMPTE/DIN mode, four relative amplitudes are possible: 1:1, 1:2, 1:4 and 1:10. When the SMPTE/DIN IMD mode is selected, the 1:4 ratio is automatically set (the SMPTE/DIN standard). A different ratio can be selected by using a SPECIAL FUNCTION (SPCL). Special Function 35 is reserved for IMD ratio. 35.1 SPCL sets a 1:1 ratio, 35.2 sets a 1:2 ratio, 35.4 sets a 1:4 ratio and 35.10 sets a 1:10 ratio (special functions do not require a prefix key). To set a ratio, key in the correct numeric code (e.g. 35.4) and terminate by pushing the SPCL key. Special Function 35.0 can be used to view the currently set ratio.

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2.3 INSTRUMENT SETUP STORES

Twelve non-volatile memories are provided in the 5500 to store instrument setups. Two positions are reserved for power-on default state and last power-down state respectively while the remaining ten positions are user accessible.

The instrument normally powers up in a factory defined default state stored in memory position 0. This clears any unusual settings and assures the user of a known start configuration. A list of the position 0 default states is given in Section 2.6. (Alternatively, the instrument can be changed to power up in Memory 1 state, use SPCL FNCT 23.1. See the note on the next page.)

Position 1 is the complete state of the instrument when power was last turned off.

Positions 2 through 11 are ten user definable memories for convenient recall of special test setups.

Note that the instrument always stores its complete status, that is, **everything** that can be set by the front panel, in the selected memory. The user may subsequently elect to request either a partial recall, that is, only the frequency and amplitude of the oscillator or a total recall.

To recall a total instrument setup, key in a number from 0 to 11, the decimal point, the digit 1 then terminate with the RECALL key. For example:

This will effect a **total** recall of what the user previously stored in memory 4 (if nothing has been stored, error 6 is generated). For a partial recall, omit the decimal and digit 1. That is, 4 RECALL will recall only the frequency and amplitude of the generator previously stored in position 4.

To store the current status of the instrument, key in a number from 2 to 11 followed by the STORE terminator (STORE is a shifted version of RECALL).

Remember the instrument always does a **total** store but the user may elect either a partial or total recall. User available storage positions are 2 through 11. Positions 0 and 1 are automatically stored and only available for user recall.

Note :

When recalling a complete instrument state (i.e. 2.1 through 11.1), the current instrument state is automatically stored in memory 1 prior to the total recall. (This does not occur on a partial recall - 2 to 11.) Thus it is possible to alternate between a just used setup and a previously stored setup. Or, if the recalled memory inadvertently contains an unwanted instrument setup, the operator can quickly return to the previous state by keying in 1.1 RCL.

The storing of the complete instrument state in position 1 at power down is only guaranteed if the instrument is powered down using the front panel POWER push button. If power down is effected by removal of mains from the rear panel, the instrument may properly store its state in position 1 but this is not guaranteed. (This is related to power supply filter capacitor holdup voltage time. The sequence of events is predictable when using the front panel POWER push button but not with a simple removal of mains.)

As stated earlier, the instrument always powers up in its default state (Memory 0). Alternatively, the instrument can be modified to power up in the same state it was in during a valid power-down sequence.

To change the instrument to power up in the last power down state, key in 23.1 SPCL. The **next** time the instrument is powered up, it will start in the last power-down state. To return to the normal default power-up state, key in 23.0 SPCL.

If the last state at power-down was not successfully stored for any reason, at next power up, the default status will be recalled rather than an erroneous and possibly illegal state. The instrument always checks the validity of data prior to a recall to avoid placing the instrument in an invalid state.

2.4 SPECIAL FUNCTIONS

There are several lesser used parameters that can be set using SPECIAL FUNCTIONS. Examples are dBm impedance reference, certain GPIB functions, etc. SPECIAL FUNCTIONS are also used for diagnostic purposes, special programming, to override auto-ranging and other unusual situations.

The syntax for Special Function entry is the special code followed by the SPCL key. No prefix is required. Many special functions have a two part code separated by a decimal point. The first part of the code specifies the function while the second part of the code the sub-function, value, etc.

For example, the dBm impedance can be set using Special Function 26. To set a 150 ohm reference, enter 26.150 SPCL. The following are some of the more commonly used special functions.

2.4.1 WATTS IMPEDANCE REFERENCE

The meter can express the input signal level as a power reading by calculating a Watts value using the measured input Voltage and a stored impedance reference. The default value is 8 ohms but the user can change the stored reference to be any value between 1 and 999 ohms inclusive. Use Special Function 25 followed by a decimal followed by the desired impedance followed by the SPCL terminator key. For example, to set a value of 16 ohms key in :

2 5 . 1 6 SPCL

The currently stored impedance reference can be displayed by using Special Function 25.0.

2.4.2 dBm IMPEDANCE REFERENCE

dBm is in fact a power ratio measurement expressing a measured signal level relative to a power of 1 mW. The 5500, like most dBm meters, measures dBm by measuring volts and calculating the power presuming a reference impedance. The default impedance is 600 ohms. However, the user can change the reference to be any value from 1 to 999 ohms inclusive using Special Function 26. To set a dBm impedance reference of 150 ohms, for example, key in:

2 6 . 1 5 0 SPCL

To display the currently set value of dBm impedance reference use Special Function 26.0.

Remember that the 600 and 150 ohm input terminations automatically select 600 and 150 ohms respectively as the reference. Also, the dBm reference described here is for LEVEL measurements only and does not affect Generator level dBm settings which have their own independent reference.

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2.5 ERROR CONDITIONS

The 5500 has a comprehensive set of error trapping programs to avoid ambiguous results, prevent instrument damage or warn the operator if invalid operations are attempted.

The errors are of several classes depending on their origin and are handled according to an established level of priority.

2.5.1 COMMAND ENTRY ERRORS

These result from an erroneous front panel operation by the operator (for example, requesting a frequency of 1 Volt). They are cleared by pushing the CLEAR key and starting again. The following table lists the errors by number.

2.5.2 MEASUREMENT ERRORS

These errors result from invalid signals present at the input. For example, with a signal below -30 dBm (30 mV), no distortion reading can be obtained. They are cleared by correcting the input signal within approximately 20 seconds of the condition. After this time, the condition must be corrected and the CLEAR key pushed.

For example, if a signal of -60 dBV (1 mV) is being measured in the LEVEL mode and then one of the distortion modes is selected, error 21 will be displayed (signal level too low for distortion). If the signal is increased in level to -30 dBV or more within 20 seconds, the error will be cleared and a distortion reading will be displayed. If longer, and the signal is both raised and the CLEAR key pushed, the distortion reading will be displayed. If the signal amplitude cannot be increased, a new (valid) function could be selected, LEVEL for example, to clear the error.

ERROR CODE SUMMARY

COMMAND INPUT ERROR CODES

1	Invalid Special Function suffix
2	Unrecognized command
3	Invalid string character
4	Invalid numeric string
5	Invalid terminator
6	Invalid command operand
7	Operand out of range
8	Invalid Special Function prefix
9	GPIB input code error

MEASUREMENT EXCEPTION CODES

11	Signal at PGA out over range: PGA gain decremented
12	Signal at PGA out under range: PGA gain incremented
13	Signal at PGB out over range: PGB gain decremented
14	Signal at PGB out under range: PGB gain incremented
15	Signal at PGC out over range: PGC gain decremented
16	Signal at PGC out under range: PGC gain incremented
17	SVF not tuned to input signal: SVF frequency adjusted

MEASUREMENT ERROR CODES

20	Signal at PGA out over range and can't adjust
21	Signal at PGA out under range and can't adjust
22	Signal at PGB out over range and can't adjust
24	Signal at PGC out over range and can't adjust

MEASUREMENT ERROR CODES

26	Signal frequency is out of range for SVF tuning
27	Can't tune SVF due to lack of frequency reading.
28	Can't measure distortion due to lack of hardware synch'd amplitude reading
29	IMD mix mismatch
30	Level calculation overflow or DC too negative
31	Can't tune SVF due to frequency counter overflow
32	DC too positive
34	Can't auto-range due to instability of input signal
35	Can't tune SVF due to instability of input signal
37	Level calculation underflow
38	Distortion calculation underflow
39	Ratio Calculation Underflow
40	Ratio Calculation Overflow
41	Distortion calculation overflow
42	Level/distortion display overflow
44	Measurement readings lost
47	Can't get frequency reading
49	Frequency calculation overflow
50	Frequency display overflow
60	AUTOCAL failure
99	ROM failure

2.6 DEFAULT STATES

The following table gives the instrument default states at power on.

These are stored in memory position 0 and are automatically set into the instrument at power on.

PARAMETER	DEFAULT STATE
Detector Speed	SLOW
Detector Selected	RMS
HP Filter	OFF
Weighting Filters	OFF
Input Selected	A
Servo	OFF
PGA Gain/Attenuation	-35 dB
PGB Gain	0 dB
PGC Gain	0 dB
Input Termination	100 k Ohms
Output A	OFF
Output Reference	GROUND
Output Structure	600 Ohms (BAL)
Programmed Source Amplitude Units	V
Ouput Load Impedance Reference, Level	INFINITY
Ouput Load Impedance Reference, Power	600 Ohm
Source Amplitude	0.0 V
Source Frequency	1.0 kHz
SVF Frequency	1.0 kHz
IMD Offset Frequency (requires option 002)	60 Hz
Distortion Reference	100.0 %
Level Reference	1.0 V
Source Amplitude Increment	1.0 V
Source Frequency Increment	1.0 Hz
SVF Frequency Increment	1.0 Hz
dBm Impedance	600 Ohms
Watts Impedance	8 Ohms
Operating Mode	AUTO
Amplitude Display Units	V
Amplitude Display Decimal Point Position	DDD.DD
Frequency Display Units	Hz
Frequency Display Decimal Point Position	DDD.DD
Frequency Measurement Source	INPUT

PARAMETER	DEFAULT STATE
Narrow Band Measurement Type	VERY WIDE BP
Front Panel Special Amplitude Display	OFF
Front Panel Special Frequency Display	OFF
Amplitude Display Units Operating Mode	FLOATING
Amplitude Display Decimal Operating Mode	FLOATING
Frequency Display Decimal Operating Mode	FLOATING
PGA Operating Mode	AUTO
PGB Operating Mode	AUTO
PGC Operating Mode	AUTO
SVF Tuning Mode	HOLD
Detector Speed Mode	AUTO
Numeric Entry Mode	SOURCE AMPLITUDE
IMD Mix Ratio (requires option 002)	1:1
Measurement Mode	FREE RUN
Relative Measurement Enable	OFF
Measurement Type	WIDE BAND
Output B (requires option 007)	OFF
Power amp source select	INTERNAL
Absolute Units	V
Output Configuration	A ONLY
Output Enable	OFF
Programmed Source Amplitude	0.0 V
DC Range (requires option 008)	100 V
Phase Scale (requires option 009)	±180
DC Volts Measurement Mode (requires option 008)	OFF
Phase Measurement Mode (requires option 009)	OFF
DC Feedback (requires option 008)	FULL
DC DAC A (requires option 008)	0
DC DAC A (requires option 008)	0
DC Multiplexer (requires option 008)	OUTPUTS OFF
DC Digital Utility (requires option 008)	0

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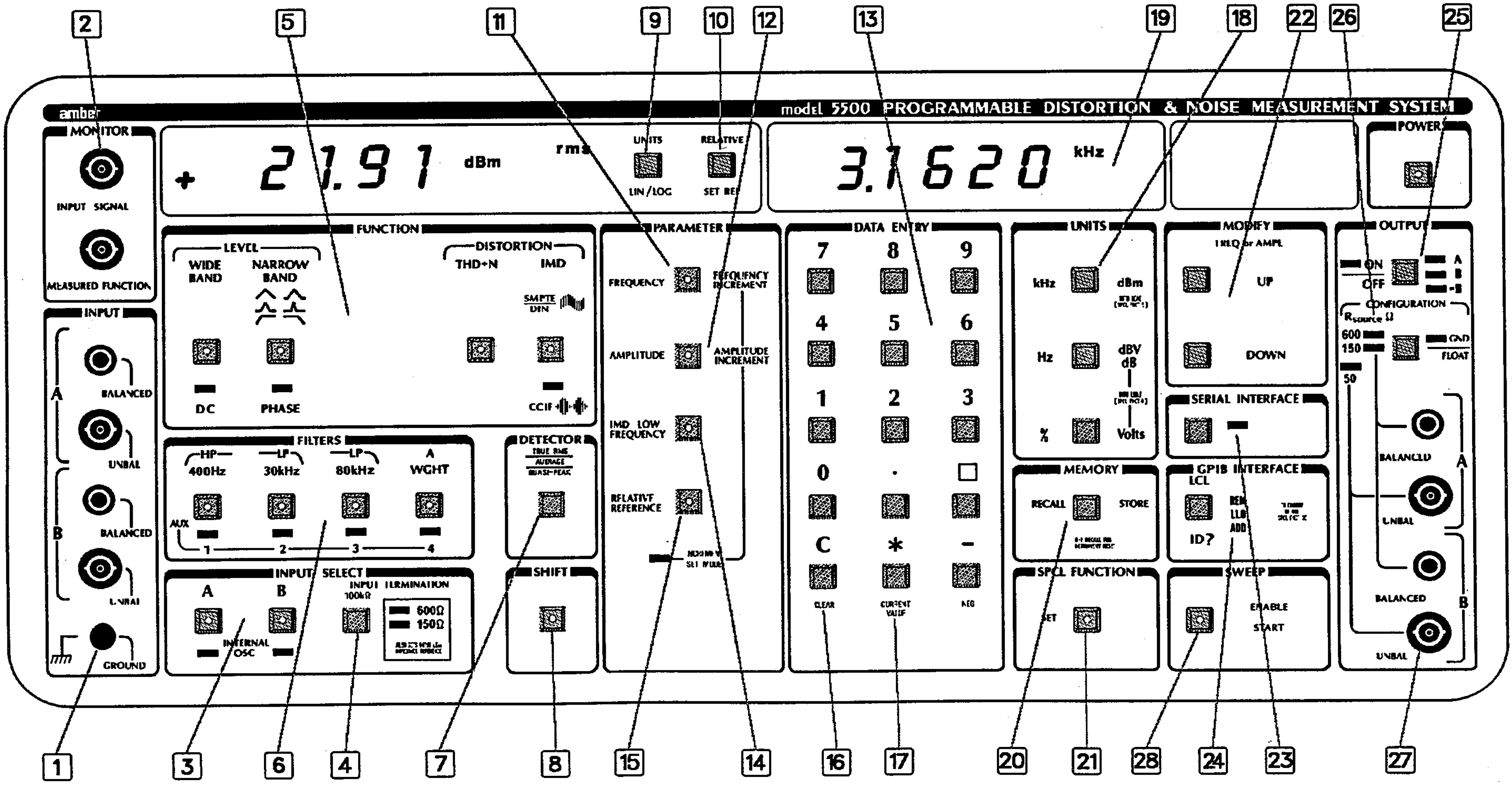
amber
model 5500 PROGRAMMABLE DISTORTION & NOISE MEASUREMENT SYSTEM
MONITOR
INPUT SIGNAL
MEASURED FUNCTION
INPUT
A
BALANCED
UNBAL
B
BALANCED
UNBAL
GROUND
+ 21.91 dBm
rms
UNITS
LIN/LOG
RELATIVE
SET REF
3.1620 kHz
POWER
FUNCTION
LEVEL
WIDE BAND
NARROW BAND
DC
PHASE
DISTORTION
THD+N
IMD
SMPTE
DIN
CCIF
FILTERS
HP
400Hz
LP
30kHz
LP
80kHz
A
WGHT
AUX
1
2
3
4
INPUT SELECT
A
B
INTERNAL OSC
INPUT 100kΩ
TERMINATION
600Ω
150Ω
DETECTOR
TRUE RMS
AVERAGE
QUASI-PEAK
SHIFT
PARAMETER
FREQUENCY
FREQUENCY INCREMENT
AMPLITUDE
AMPLITUDE INCREMENT
IMD LOW FREQUENCY
RELATIVE REFERENCE
DATA ENTRY
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8
9
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CLEAR
CURRENT VALUE
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UNITS
kHz
dBm
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dBV
dB
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Volts
MEMORY
RECALL
STORE
SPCL FUNCTION
SET
MODIFY
FREQ or AMPL
UP
DOWN
SERIAL INTERFACE
GPIB INTERFACE
LCL
REM
LLO
ADD
ID?
SWEEP
ENABLE
START
OUTPUT
ON
OFF
A
B
-B
CONFIGURATION
Rsource Ω
600
150
50
GND
FLOAT
A
BALANCED
UNBAL
B
BALANCED
UNBAL
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1) Connect output of device under test to either BALANCED or UNBALanced input connector. Balanced jack is telephone style tip/ring/sleeve and requires mating WE310 or PJ051 type plug. GROUND post is chassis; connect to chassis of device under test.

2) Connect dual trace oscilloscope to INPUT and MEASURED FUNCTION outputs to monitor signal. INPUT is auto-ranged input signal; MEASURED FUNCTION is input signal after any weighting filters in WIDE BAND LEVEL, input signal after weighting and tunable filter in NARROW BAND LEVEL and distortion residual products (i.e. signal with fundamental removed) after weighting filters in all DISTORTION modes.

3) Select one of two inputs or one of two outputs as the input signal to the meter/analyzer.

4) Select input termination impedance on both A and B inputs. Selecting 600 or 150 ohms also sets dBm reference impedance for dBm measurements (may be changed using SPCL FNCT 26). Do not exceed power rating of termination resistors. (See Section 2.1.9 of user's manual.) Note: terminations only apply to EXTERNAL inputs, not internal oscillator connection.

5) Select measurement function. WIDE BAND LEVEL measures signals and noise from 10 Hz to over 500 kHz and +40 dBm/dBV/100 V to below -120 dBm/dBV/1 V. NARROW BAND LEVEL same as WIDE BAND but 10 Hz to 100 kHz set by FREQUENCY command (see 11 below). THD requires fundamental between 10 Hz and 100 kHz and signal level between +40 dBm/dBV/100 V and -30 dBm/dBV/ 30 mV. IMD same except lower frequency limit for HF component is 2 kHz. SMPTE is mix of a high and a low frequency signal with measurement of AM products of HF signal. CCIF is mix of two HF signals with measurement of difference frequency component. Note: IMD function requires option 002.

6) Select weighting or band limiting filters. Permissible selection includes HP filter plus one of remaining 7 filters. Four auxiliary filters require option 005 or 006. Avoid selection of a filter that would eliminate a frequency band of interest.

7) Select DETECTOR characteristic. TRUE RMS accepts crest factors AVERAGE is fastest and yields average of absolute value. QUASI-PEAK measures to CCIR 468-3 spec. All detectors are rms calibrated (will indicate same value on a pure sine wave).

8) SHIFT key. All front panel functions labelled in green require pushing and holding SHIFT key while selecting the green, shifted function.

9) Select display units. LEVEL modes have a choice of four units, two in log (dBV, dBm) and two in linear (V, W). DISTORTION modes have a choice of two units : dB in log and % in linear. LIN/LOG choice is a shifted function. (see SPCL FNCT 25 for Watts and SPCL FNCT 26 for dBm impedance reference)

10) Relative mode shows current measured value in comparison to a previously stored reference (see 15 below). In log, units are dB, in linear units are %. First push enables relative mode (using previously stored reference), second push disables relative mode and returns to absolute mode (without altering stored reference). If in the absolute mode, pushing SHIFT and RELATIVE simultaneously modifies the stored reference to be the currently measured value and enables the relative mode - display will show 0dB or 100% until measured value changes.

11) FREQUENCY prefix is used to enter a generator (and filter) frequency. SHIFT of FREQUENCY is the FREQUENCY INCREMENT prefix. Next entry is DATA (see 13 below) followed by a UNITS terminator (see 18 below). Example, FREQUENCY 100 Hz.

12) AMPLITUDE prefix is used to enter a generator output amplitude. SHIFT of AMPLITUDE is the AMPLITUDE INCREMENT prefix. Next entry is DATA (see 13 below) followed by a UNITS terminator (see 18 below). Example, AMPLITUDE 2 0. 0 dBm. Amplitude is always into user specified external load (see SPCL FNCT 4 and 5).

13) DATA keys. Used to enter a numeric quantity for FREQUENCY, AMPLITUDE, REFERENCE, MEMORY or SPCL FNCT.

14) Prefix for entering IMD low frequency. Data entry will define the SMPTE LF frequency and the CCIF Offset frequency (one half of difference frequency). Choices are 40, 50, 60, 80, 100, 125, 250 and 500 Hz. Other entries will be rounded to closest available value. (Requires IMD option 002.)

15) Prefix for relative reference. Next entries should be data followed by dBm, dBV, dB, V or % terminator (also see 10 and 17).

16) CLEAR key. Used to cancel an uncompleted data entry, correct errors, etc. Also cancels SPCL FNCT 10.

17) CURRENT VALUE. Can be used with any prefix key in lieu of manual data entry (13 above). Uses current measured value as data. Does not require a terminator.

18) Terminator keys. Used to terminate a data entry begun by pressing a prefix key. Note: when terminating an AMPLITUDE entry, the dBm units terminator uses user specified external load impedance selected by SPCL FNCT 4; dBV and V units terminators that of SPCL FNCT 5.

19) OSC indicator in FREQUENCY display. When lit, SPCL FNCT 37 is enabled. Means indicated frequency and auto-tuning is referenced to the internal oscillator rather than the (external) signal on the INPUT.

20) MEMORY terminator. To store an instrument setup, select a memory from 2 to 11 using the data entry keys then push SHIFT and MEMORY (store) as a terminator. To partially recall (frequency and amplitude of generator only), select the memory location using the DATA key (2 to 11) then push the RECALL button. A full state recall is N.1 followed by RECALL where N is the memory number.

21) SPCL FUNCTION terminator (see the SPCL FNCT code summary). To enter a special function, key in the required digits and terminate with the SET key.

22) MODIFY keys. Pushing UP (or DOWN) will increment (or decrement) the FREQUENCY or AMPLITUDE by the previously user stored INCREMENT value. Push FREQUENCY or AMPLITUDE prefix key first then UP or DOWN.

23) Enables data output from serial port (if option 232 is provided). When enabled, output data can be viewed on an external suitably configured data terminal. Adds a time burden to instrument when enabled. (Serial port input is always enabled to accept commands.)

24) GPIB INTERFACE. If instrument in REMOTE mode and not LOCAL LOCKOUT, pushing this key will return the instrument to LOCAL. Pushing SHIFT and this key (ID?) displays the instrument's GPIB address and status.

25) OUTPUT status. Push on, push off button enables selected output(s) or provides quiet termination. SHIFTED mode of button selects outputs : A only, B only, A and B in-phase and A and B out-of-phase. (Note B output only present if option 007 is installed.)

26) OUTPUT CONFIGURATION. This key determines the style of the output. The primary mode selects 600 ohm balanced, 150 ohm balanced or 50 ohm unbalanced. IMPEDANCES refer to the generator source impedance (as opposed to the user specified external load impedance). Be sure to take the signal from the appropriate output connector. Pushing SHIFT and this key alternately selects GND (generator common or balanced center tap connected via approximately 500 ohms to analyzer ground) or FLOATing. Correct selection will avoid ground loops or ungrounded, floating circuits. Note: Balanced Output modes require option 001.

27) Connect INPUT of device under test to either the BALANCED or UNBALanced OUTPUT connector. Balanced jack is telephone style tip/ring/sleeve and requires mating WE310 or PJ051 type plug.

28) SWEEP enable key. (Requires option 054.) When pushed, places 5500 in SWEEP mode freezing all auto-ranging and measurement activity. Pushing any front panel key or sending any command to the GPIB or SERIAL ports will cancel the SWEEP mode and return the 5500 to normal operations.

SPECIAL FUNCTION CODE SUMMARY

INTERNAL GAIN/LOSS CONDITIONS

Set PGA Autorange Mode	1.0 SPCL
Hold Current PGA Gain	1.1 SPCL
Select & Hold -30dB PGA Loss	1.2 SPCL
Select & Hold -25dB PGA Loss	1.3 SPCL
Select & Hold -20dB PGA Loss	1.4 SPCL
Select & Hold -15dB PGA Loss	1.5 SPCL
Select & Hold -10dB PGA Loss	1.6 SPCL
Select & Hold -5dB PGA Loss	1.7 SPCL
Select & Hold -0dB PGA Loss	1.8 SPCL
Select & Hold +5dB PGA Gain	1.9 SPCL
Select & Hold +10dB PGA Gain	1.10 SPCL
Select & Hold +15dB PGA Gain	1.11 SPCL
Select & Hold +20dB PGA Gain	1.12 SPCL
Select & Hold +25dB PGA Gain	1.13 SPCL
Select & Hold +30dB PGA Gain	1.14 SPCL
Select & Hold +35dB PGA Gain	1.15 SPCL
Set PGB Autorange Mode	3.0 SPCL
Hold Current PGB Gain	3.1 SPCL
Select & Hold 0dB PGB Gain	3.2 SPCL
Select & Hold +20dB PGB Gain	3.3 SPCL
Select & Hold +40dB PGB Gain	3.4 SPCL
Select & Hold +60dB PGB Gain	3.5 SPCL
Select & Hold +80dB PGB Gain	3.6 SPCL
Set PGC Autorange Mode	27.0 SPCL
Hold Current PGC Gain	27.1 SPCL
Select & Hold 0dB PGC Gain	27.2 SPCL
Select & Hold +10dB PGC Gain	27.3 SPCL
Select & Hold +20dB PGC Gain	27.4 SPCL
Select PGA, PGB & PGC Autorange Automatic Detector Speed & Tuning	9.0 SPCL
Hold PGA, PGB, PGC Detector Speed & Tuning	9.1 SPCL

RELATIVE MODE

Disable Relative Mode	11.0 SPCL
Display Level Relative Reference	11.1 SPCL
Display Distortion Relative Ref.	11.2 SPCL
Enable Relative Using Stored Ref.	11.3 SPCL
Enable Relative Using Current Value	11.4 SPCL

IMPEDANCE REFERENCES

Watts Measurement Impedance	25.nnn SPCL
dBm Measurement Impedance	26.nnn SPCL
Output dBm Load Impedance	5.nnnn SPCL
Output Volts/dBV Load Impedance	4.nnnn SPCL

SERIAL INTERFACE

Enable Serial Interface transmit	38.1 SPCL
Disable Serial Interface transmit	38.0 SPCL

TUNING MODES & DETECTOR SPEED

THD Notch Filter Follow Osc	6.1 SPCL
THD Notch Filter Auto Tune to Input	6.0 SPCL
Narrowband Follow Oscillator	28.0 SPCL
Narrowband Auto Coarse Tune	28.2 SPCL
Frequency Tuning & Sync to Input	37.0 SPCL
Frequency Tuning & Sync to osc.	37.1 SPCL
Select Detector Speed Automatic	29.0 SPCL
Hold Current Detector Speed	29.1 SPCL
Select Very Slow Detector Speed	29.2 SPCL
Select Slow Detector Speed	29.3 SPCL
Select Fast Detector Speed	29.4 SPCL
Select Very Fast Detector Speed	29.5 SPCL

MEASUREMENT PARAMETERS

Set 1 to 1 IMD Amplitude Ratio	35.1 SPCL
Set 2 to 1 IMD Amplitude Ratio	35.2 SPCL
Set 4 to 1 IMD Amplitude Ratio	35.4 SPCL
Set 10 to 1 IMD Amplitude Ratio	35.10 SPCL
Select THD Level Measure Mode	36 SPCL

GPIB FUNCTIONS

Select Left Displ (AMPL) to GPIB	20.0 SPCL
Select Right Displ (FREQ) to GPIB	20.1 SPCL
Display GPIB Address Status	21.0 SPCL
SRQ on GPIB Input error Only	22.0 SPCL
SRQ on GPIB Input or Fatal error	22.1 SPCL
SRQ on GPIB Input, Fatal error or Data Ready	22.2 SPCL
Set GPIB Address (address = nn)	33.nn SPCL
Set GPIB to Talk and Listen	34.0 SPCL
Set GPIB to Listen Only	34.1 SPCL
Set GPIB to Talk Only	34.2 SPCL

SPECIAL DISPLAYS

Front Panel Only

Display Source Settings	10 SPCL
Display Level Relative Ref.	11.1 SPCL
Display Distortion Relative Ref.	11.2 SPCL
Display Watts Impedance Ref.	25.0 SPCL
Display dBm Impedance Ref.	26.0 SPCL
Display IMD Ampl Mix Ratio	35.0 SPCL
Display Volts/dBV Load Impedance	4.0 SPCL
Display dBm Load Impedance	5.0 SPCL

MISCELLANEOUS

Start AUTO-CAL Sequence	24 SPCL
Select EXT IN as Output	12.1 SPCL
Select OSC as Output	12.0 SPCL
Power up in Default State	23.0 SPCL
Power up in last power down State	23.1 SPCL

DISPLAY FORMATTING

Amplitude Auto-range Units	30.0 SPCL
Ampltude Hold Current Units	30.1 SPCL
Amplitude Hold Volts	30.2 SPCL
Amplitude Hold mV	30.3 SPCL
Amplitude Hold µV	30.4 SPCL
Amplitude Hold Watts	30.5 SPCL
Amplitude Hold mW	30.6 SPCL
Amplitude Hold µW	30.7 SPCL
Select Float Pt Amplitude Display	31.0 SPCL
Hold Current Dec Pt Position	31.1 SPCL
Set DDDDD. Decimal Point	31.2 SPCL
Set DDDD.D Decimal Point	31.3 SPCL
Set DDD.DD Decimal Point	31.4 SPCL
Set DD.DDD Decimal Point	31.5 SPCL
Set D.DDDD Decimal Point	31.6 SPCL
Set .DDDDD Decimal Point	31.7 SPCL
Select Float Pt Frequency Display	32.0 SPCL
Hold Current Dec Pt Position	32.1 SPCL
Set DDDDD. Decimal Point	32.2 SPCL
Set DDDD.D Decimal Point	32.3 SPCL
Set DDD.DD Decimal Point	32.4 SPCL
Set DD.DDD Decimal Point	32.5 SPCL
Set D.DDDD Decimal Point	32.6 SPCL
Set .DDDDD Decimal Point	32.7 SPCL
Phase ±180° range	8.0 SPCL
Phase 0 - 360° range	8.1 SPCL

DC AND DIGITAL UNITY

(option 008)

DC Range 100V F.S.	2.0 SPCL
DC Range 10V F.S.	2.1 SPCL
DC Range 1V F.S.	2.2 SPCL
Optional DC gain change	85.1 SPCL
DC Utility DAC A (0 to 2.55V)	86.nnn SPCL
DC Utility DAC B (0 to 2.55V)	87.nnn SPCL
DIGITAL output (0 = off or 1 to 8)	88.n SPCL
Digital 8 bit utility (0 to 255)	89.nnn SPCL

SIGNAL SOURCE

Default Source	14.1 SPCL
IMD Composite Source	14.2 SPCL
Swept Sine Wave	14.3 SPCL
External Input	14.4 SPCL
External In and IMD LF	14.5 SPCL
Swept Sine IMD	14.6 SPCL
Square Wave	14.7 SPCL
Aux Source 1	14.8 SPCL
Aux IMD Source	14.9 SPCL
Aux Source 2	14.10 SPCL
Aux Source 3	14.11 SPCL
Aux Source 4	14.12 SPCL
Fine tune default sine	13.nnn SPCL

10500 Hz

949 Hz